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PROGRAMME**FOR RESEARCH OPERATIONS AT OCEANIC TEST SITES**

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§ I. The main tasks.

The principal aim of investigation of the oceans is the study of:

- a) processes of mutual adaptation of wind, current and density fields in the ocean;
- b) balance of forces in the average circulation field of the central part of the ocean;
- c) internal waves;
- d) abyssal circulation;
- e) vertical and horizontal turbulence;
- f) regularities of turbulent mixing at the ocean-atmosphere boundary in the presence of wind waves;
- g) processes of the interaction between turbulent wind and sea waves;
- h) turbulent heat exchange at the ocean-atmosphere boundary.

This aim leads to the necessity of carrying out specific expeditionary operations during the period of, at least, three years. Continuous observations in separate points of the test site should constitute a basis for such operations.

The main task of the first year is a preliminary determination of the volume of the investigated phenomena in time and space. This determination is quite necessary to define correctly both distance between the points of observations

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and the duration of the continuous observations' cycle necessary for the solution of the main tasks. At the same time data are being collected on all the above-mentioned problems. Besides, practical and technical aspects of the study should be elaborated completely during the first year for approximately the same methods are to be used during the subsequent years.

§ 2. Operational area and
the duration of research.

For the implementation of the above-mentioned tasks an operational area should be chosen far from the zones of sharp changes of hydrological characteristics (frontal zones, etc.) and must have a comparatively flat bottom. Otherwise, the nature of the phenomena investigated would be concealed, for example, by frontal displacements or by the bottom roughness effects.

Bearing in mind the existence of fluctuations of hydrological elements with tidal and inertial periods it would be desirable to have an opportunity of their maximum distinct identification. The area at 48-49° N is the most suitable one from this point of view. The operational area is chosen near the point with coordinates 48°N and 19°W (Atlantic Ocean) and 49°N and 164°E (Pacific Ocean).

The duration of the first year observations should be no less than 4 months. In future it is planned to prolong STAT the period of the buoy operations to one year.

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§ 3. Stages of work.

The proposed stages of work imply that after the buoy is installed the ship can go any distance away from it and to find it on return without great difficulty. Otherwise the carrying out of research operations at oceanic test sites would become impossible. The work is to be carried out by no less than four vessels simultaneously. The lesser number of vessels will make it impossible to perform three synchronized many-days stations and to recharge systematically the buoys.

The work consists of the following stages:

a) echometric survey of the microarea for buoy operations with the aim of choosing points for their anchoring. This work will require about 1 day.

b) Anchoring of seven buoy stations supplied with current meters and temperature recorders. The buoys are stationed in accordance with the given scheme so that distances between them are correspondingly: $AB=AC=10$ miles, $BD=CE=30$ miles, $DF=EG=60$ miles. Current meters are set at standard depths - 50, 100, 200, 500, 750, 1000, 1500, 2000, 3000, and 4000 m - 10 current meters in all. Recording interval should be 30 minutes. Besides seven upper current meters at each of the buoy stations are combined with temperature recorders. After a buoy is anchored the ship remains by it with the aim of exact determining its location by means of radar and astronomical observations.

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Before leaving the given point the ship should perform one series of hydrological observations down to the bottom. These operations will require about 4 days.

c) Performing of two perpendicular cross-sections, each 100 miles long, crossing in the point A of the scheme and having meridional and parallel directions. The object of these operations is to verify methods for computing quasistationary current speeds at a given density distribution and to clear up a large-scale hydrological pattern of the investigated area. Stations at the cross-sections are performed at an interval of 100 miles each. All the stations are carried out down to the bottom. In fact, each of the four vessels carries out its own part of one of the cross-sections.

The above work will require about 5 days.

d) Performing of three synchronized many-days stations of 45 days' duration at the buoys A, D and E. Hydrological series are carried out at the many-days stations every third hour down to the depth of 1500 m.

Bathometers in these series are set at depths: 0, 10, 25, 50, 75, 100, 150, 200, 300, 400, 500, 750, 1000, 1250, 1500 meters - 15 levels in all. Ten lower bathometers should be fit with thermic depth gauges. Thus, each of the three vessels is to carry out 540 hydrological series of observations. The fourth one provides for timely winding up the recorders at buoy stations and, if necessary, replaces one of the vessels performing many-days stations. The latter operation should be done so that breaks in observations were mini-

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mized. As it was mentioned above this work will require about 45 days.

e) Repetition of the operations described under "c" which will require about 5 days.

f) Studying of horizontal turbulence with the help of floating indicators using the methods of the R/V "Kityaz" which consist in periodical recording distances between the floats let out from board the ship. In that way horizontal turbulence within 10 miles range can be studied from one ship. As these operations will be carried out by at least three ships simultaneously it becomes possible by combining the results of observations obtained by different ships to study turbulence within 100 miles range approximately. Besides, deep oceanic current speeds are measured using floats of neutral buoyancy.

These operations will require about 30 days.

g) Repetition of the work mentioned under "c" which will require about 5 days.

h) Removal of all buoy stations. The work will require about 3 days.

1) Physics of the boundary layer study which consists in: 1) measuring vertical wind profiles, temperature and humidity above sea surface; 2) wave undulations of sea surface at different wave regimes; 3) vertical temperature profiles in the upper sea layer, about 100 meters in thickness. The work is carried out by separate serial observations according to instructions of the administration of the expedition provided the corresponding hydrometeorolo-

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gical conditions are available during the whole period of observations.

All the work mentioned above will require 98 days. The rest 22 days will be in reserve and are to be used in accordance with instructions of the administration of the expedition.

Processing of data and results to be expected

As a result of the above-mentioned operations which are, in fact, prolonged experiments in the ocean and also of the processing and scientific analysis of data the following results are expected to be obtained during the five-year period of the operations:

1) Working out of computing methods for the elements of internal waves in the ocean.

2) Determination of the balance of forces in the ocean at different space and time scales of averaging without which the prediction and computation of quasistationary, averaged and unstable circulation in the ocean would be impossible.

3) Solution of the problem on the possibility of geostrophic approximation in the central part of the ocean and application of indirect methods of sea currents computing (dynamical method, etc.) in quasistationary (averaged) and unstable conditions.

4) Determination of deep sea current average speeds and shifting periods.

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5) Obtaining of variability characteristics (spectra) of different hydrological elements (currents, density, salinity, temperature).

6) Determination of parameters of horizontal turbulent diffusion and elaboration of methods for finding free-floating objects (mines, floats, ships out of control, etc.).

7) Working out of computing and prediction methods for statistical characteristics of temperature and speed turbulent pulsations in the boundary ocean-atmosphere layer.

8) Working out of computing and prediction methods for parameters of the isothermal upper sea layer and for those of thermocline.

9) Elaboration of theoretical principles for long-term predictions of quasistationary (averaged) hydrological conditions (currents, density field) on the basis of long-range weather forecasts.

IO) Elaboration of theoretical principles for computing the variability of hydrological conditions in the ocean (currents, sea level, density, etc.) caused by travelling atmospheric disturbances.

**INTERNATIONAL PROGRAMME
FOR GEOLOGICAL-GEOPHYSICAL STUDY OF THE OCEANS**

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The object of the programme is study of the age, origin, geological history and structure of the oceans as well as the working out of the united absolute scale of the Quarternary period for the whole of the Earth.

This object is achieved by accomplishing geological-geophysical operations along the system of trans-oceanic meridional sections, by deep well drilling the loose sediments of the ocean bottom down to the basalt layer and by carrying out research operations at the base geological-geophysical test sites.

The meridional sections are performed approximately along the median lines of the main ocean basins at the greatest distance away from the continents and islands as well as from the mid-oceanic ridges.

The meridional sections cross the main climatic and structural zones of the oceans. Four oceanic sections altogether are planned to be performed during the first stage of the operations: two sections in the Pacific Ocean and one section in each of the Atlantic and Indian Oceans.

Deep drilling of the loose sediments is also carried out along the meridional oceanic sections within the zones convenient from the point of view of their hydro-meteorological conditions.

Oceanic geological-geophysical test sites are located on the meridional sections or close to them on the main oceanic structures (ocean bed, submarine elevations, etc.,). The tentative number of the test sites

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on each of the meridional sections is 3, 12 test sites in all.

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Programme for research operations on the meridional sections includes: grab sampling in the upper layer of the bottom sediments, taking of long cores of a great diameter, study of suspension from the surface to the bottom. Geothermic gradient determination, sampling for paleomagnetic investigations, measurements by the seismic reflection method. Bottom photography and underwater filming. Stations begin with anchoring a buoy aiming to locate the soundings, to measure currents and to determine the primary production.

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Standard hydrological and hydrochemical investigations. Before the observations begin a detailed sounding is conducted at a site of 20 X 20 miles in size for defining the most representative place for the ship's station. The total duration of the station is about 2 days. The stations are performed at about 100-120 miles intervals.

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Deep well drilling operations are carried out after geological-geophysical conditions on the meridional sections are found out.

The oceanic well drilling at present cannot be done everywhere because of weather conditions, calm zones are the most favourable ones. The drilling is accomplished through the whole depth of the loose bottom sediments with sampling in the upper layer of the bedrock.

Distances between wells are determined experimentally taking account of possible coordinating the stratigraphic horizons in the loose ocean sediments.

While drilling in the Atlantic Ocean it is desirable to coordinate the location of wells with the Project "Loco" (USA) investigations.

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Base geological-geophysical test sites are intended for study of the principal structure areas of the ocean bottom in its key regions.

The tentative area of the test sites is from 100 x 100 to 200 x 200 miles.

Programme of research at the test sites consists of:

1. Echo-sounding with precision recording on the grid of tacks at intervals of about 10 miles; stratigraphic recording in the upper part of bottom sediments, magnetometric determinations, gravimetry. At some places the grid of tacks thickens.

2. Research at stations. A net of the stations is located along the tacks 20 miles apart thickening in separate areas.

Observations at the stations are conducted according to the programme analogous to that of the meridional section stations except for the buoys' anchoring.

3. Work^{X)} at bottom autonomic geological-geophysical stations placed in the corners of the test site and in its centre (five stations for a site).

The complex of operations of each geological-geophysical station should include seismic and gravity measurements, heat flux determination, the velocity of diffusion through bottom using labelled atoms, fixing of the processes going on the bottom surface with the help of slow speed

X) The above mentioned work is included into the programme after working out and industrial manufacturing bottom geological-geophysical stations.

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filming; velocity and direction determination of currents in the bottom layer, fluctuations of bottom temperature, bottom hydrochemical sampling. At the same time the autonomic geological-geophysical station should be an anchor load for the buoy automatic hydrological station. The total duration of work at the base geological-geophysical sites is about 2 months.